



## **Useful Tree Species for Africa, A species selection tool based on The Vegetation Map of Africa. Companion to the map**

### **How the Useful Tree Species for Africa tool was created, version 1.1**

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# Useful Tree Species for Africa

## Version 1.1

A species selection tool based on The Vegetation Map of Africa

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### *How the Useful Tree Species for Africa tool was created*

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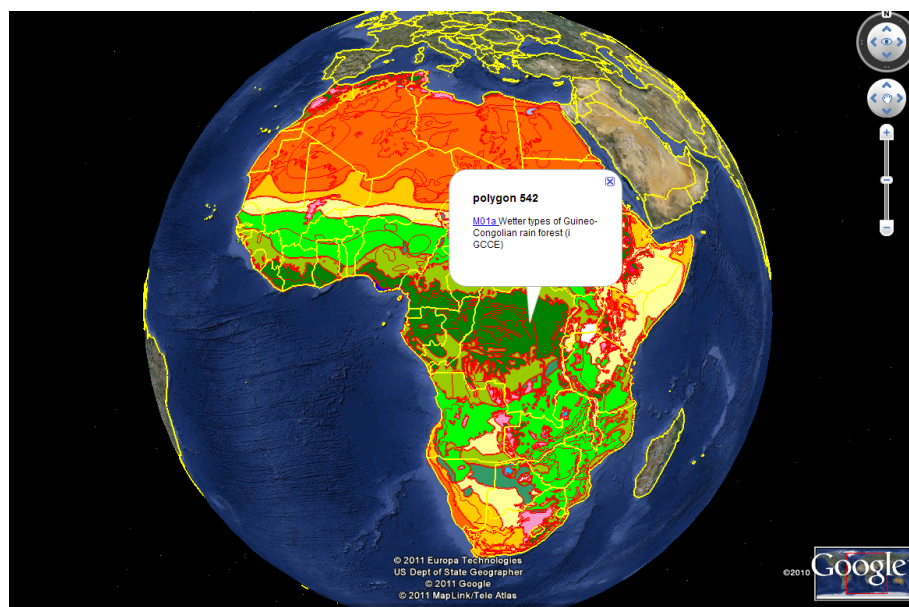
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# 1. Introduction

Frank White published a vegetation map of Africa at a scale of 1 : 5,000,000 [*i.e.* 1 mm on the map represents 5 km in the real world] comprising three map sheets, a legend and an accompanying descriptive memoir in 1983 (a French translation was published in 1986). This map was prepared by the Vegetation Map Committee (consisting of A. Aubréville, L.A.G. Barbosa, L.E. Codd, P. Duvigneaud, H. Gaussen, R.E.G. Pichi-Sermolli, H. Wild and F. White) of AETFAT (the *Association pour l' Étude de la Flore de l' Afrique Tropicale*) after UNESCO had invited AETFAT to collaborate in mapping the world's vegetation at a scale of 1 : 5,000,000. We mostly studied the mainland Africa sections of this vegetation map.

Mapping units of the Vegetation Map of Africa reflect both a **physiognomic** (*i.e.* based on vegetation structure) and a **phytochoristic** (*i.e.* based on floristics and areas of plant endemism) **classification system** of African vegetation types. In the legend of the map, mapping units are grouped according to physiognomy. In the descriptive memoir, the mapping units are grouped according to the phytochoria. For example, mapping unit 2 (drier types of Guineo-Congolian forest) is listed in the legend as one of the ten forest vegetation types, whereas descriptions for this mapping unit are given in chapters of the memoir describing the Guineo-Congolian Region, the Guineo-Congolia to Zambezia transition zone, the Guineo-Congolia to Sudania transition zone and the Lake Victoria mosaic.

In 2012, we created an updated version of the “useful tree species for Africa” tool. This updated version expanded the links to other databases (such as <http://www.tropicos.org/> and <http://www.theplantlist.org/>). Gaby Schmelzer provided information on the “PROTA star rating system” (see section 7 “Species composition tables in MS Excel”). A major change was also that we provided all information (species composition of vegetation types, information on products and services of species) in one rather than two Excel tables.

## 2. Physiognomic classification system of the Vegetation Map of Africa

The definitions of the 16 main physiognomic types are provided on page 46 of the memoir.

- **Forest:** a continuous stand of trees at least 10 m tall with interlocking crowns
- **Woodland:** an open stand of trees at least 8 m tall and with a canopy cover of 40 percent or more (but never densely interlocking). The field layer is often dominated by grasses.
- **Bushland:** an open stand of bushes (usually between 3 and 7 m tall) with a canopy cover of 40 percent or more
- **Thicket:** a closed stand of bushes and climbers usually between 3 and 7 m tall
- **Shrubland:** an open or closed stand of shrubs up to 2 m tall
- **Grassland:** land covered with grasses and other herbs, either without woody plants or woody plants covering not more than 10 percent of the ground
- **Wooded grassland:** land covered with grasses and other herbs with woody plants covering between 10 and 40 percent of the ground
- **Desert:** arid landscapes with a sparse plant cover except in depressions where water accumulates
- **Afroalpine vegetation:** physiognomically mixed vegetation occurring on high mountains where night frosts are liable to occur throughout the year
- **Transition woodland:** a transitional vegetation formation of local extent that is intermediate between forest and woodland
- **Scrub forest:** a transitional vegetation formation of local extent that is intermediate between forest and bushland or thicket
- **Scrub woodland:** a transitional vegetation formation of local extent that is intermediate between woodland and bushland (an alternative definition is stunted woodland less than 8 m tall)
- **Herbaceous fresh-water swamp and aquatic vegetation:** an edaphic formation of distinct physiognomy
- **Halophytic vegetation:** an edaphic formation of distinct physiognomy that is dominated by halophytes
- **Mangrove:** an edaphic formation of distinct physiognomy of open or closed stands of trees (or bushes) occurring on shores between the high- and low-water marks
- **Bamboo:** a formation of distinct physiognomy but restricted distribution of giant grasses (> 2 m) with erect woody stems that persist for several years.

- **Anthropic vegetation:** unnatural vegetation

The legend of the Vegetation Map of Africa lists 19 major vegetation types and mosaics.

- **Forest** (mapping units 1 to 10)
- **Forest transitions and mosaics** (mapping units 11 to 24, including forest, transition woodland, scrub forest, scrub woodland and bamboo)
- **Woodland** (mapping units 25 to 30)
- **Woodland mosaics and transitions** (mapping units 31 to 36, including woodland, transition woodland, scrub forest and scrub woodland)
- **Wooded grassland** (mapping unit 31)
- **Bushland and thicket** (mapping units 38 to 44)
- **Bushland and thicket mosaics** (mapping units 45 to 47)
- **Transitional scrubland** (mapping units 48 and 49)
- **Cape shrubland** (mapping unit 50)
- **Semi-desert vegetation** (mapping units 51 to 56, mainly consisting of shrubland and grassland)
- **Grassy shrubland** (mapping unit 57)
- **Grassland** (mapping units 58 to 61)
- **Edaphic grassland mosaics** (mapping units 62 to 64)
- **Altimontane vegetation** (mapping units 65 and 66, including afroalpine vegetation)
- **Desert** (mapping units 67 to 74)
- **Herbaceous fresh-water swamp and aquatic vegetation** (mapping unit 75)
- **Halophytic vegetation** (mapping unit 76)
- **Mangrove** ( mapping unit 77)
- **Anthropic landscapes** (mapping units 77 to 80)

### 3. Phytochoristic classification system of the Vegetation Map of Africa

Mainland Africa was divided in 8 centres of endemism, 6 regional transitions zones, 3 regional mosaics and 1 centre of extreme floristic impoverishment.

Centres of endemism include:

- (i) Guineo-Congolian Region (GCCE)
- (ii) Zambezian Region (ZCE)
- (iii) Sudanian Region (SCE)
- (iv) Somalia-Masai Region (SMCE)
- (v) Cape Region (CCE)
- (vi) Karoo-Namib Region (KNCE)
- (vii) Mediterranean Region (MCE)
- (viii) Afromontane archipelago-like centre of endemism (AMCE)

Regional transition zones include:

- (x) Guineo-Congolia to Zambezia transition zone (GCZTZ)
- (xi) Guineo-Congolia to Sudania transition zone (GCSTZ)
- (xiv) Kalahari to Highveld transition zone (KHTZ)
- (xvi) Sahel transition zone (SLTZ)
- (xvii) Sahara transition zone (SATZ)
- (xviii) Mediterranean to Sahara transition zone (MSATZ)

Regional mosaics include:

- (xii) Lake Victoria mosaic (LVM)
- (xiii) Zanzibar-Inhambane mosaic (ZIM)
- (xv) Tongaland-Pondoland mosaic (TPM)

Centre of extreme floristic impoverishment:

- (ix) Afroalpine archipelago-like centre of extreme floristic impoverishment (AACI)

## 4. The interactive vegetation maps

The interactive vegetation maps ([Africa Vegetation 2012.kmz](#)) were prepared from a shapefile available from <http://www.grid.unep.ch/data/index.php>.

**Be aware that freshwater lakes are coloured white in the vegetation map (*i.e.* the white colour represents absence of terrestrial vegetation), whereas some physiognomic vegetation types such as mangrove, herbaceous swamp or halophytic vegetation have a bluish colour.**

Suggestions how these interactive maps can be used are provided in an associated document ([Suggestions for using the maps.pdf](#)). Note that you need to install Google Earth first before you can use these interactive maps (<http://www.google.com/earth/download/ge/>).

Besides converting the shapefile format into a kmz format compatible with Google Earth and largely restricting the mapped area to mainland Africa (by excluding Madagascar and the Comoro islands), various changes were made, including:

- The two interconnected classification systems (physiognomic and phytochoristic, see above) of the Vegetation Map of Africa were followed more strictly (but not completely, see below). Where the same mapping unit occurred in different phytochoria, we included a suffix that referred to the phytochorion. For example, the original mapping unit 2 was modified into mapping units 2a (indicating the Guineo-Congolian Region), 2b (indicating the Guineo-Congolia to Zambezia regional transition zone), 2c (indicating the Guineo-Congolia to Sudania regional transition zone) and 2d (indicating the Lake Victoria mosaic). Indicating differences in phytochoria required to split several polygons of the UNEP-GRID shapefile (for example, mapping unit 54 was split in polygons for mapping unit 54a [Sahel regional transition zone] and 54b [Somalia-Masai Region]). Most of these splits were done with straight lines (so sometimes different than the original vegetation map).
- Not all polygons were split along phytochoristic boundaries, however. Several polygons of mapping units 2 or 11 that crossed the boundary between the Guineo-Congolian Region and the Guineo-Congolia to Zambezia transition zone or the boundary between the Guineo-Congolian Region and the Guineo-Congolia to Sudania transition zone were not split. In these cases, two suffixes were given to the mapping units of these polygons to show that there was a boundary between phytochoria within these polygons. When implementing polygon splits between phytochoria, we also ignored small areas of polygons that crossed the phytochoristic boundaries indicated on the original map (*i.e.* we more strictly used vegetation boundaries as boundaries of phytochoria than in the Vegetation Map of Africa).



- We crosschecked the mapping units of the original Vegetation Map of Africa (for each of the three sheets) with the mapping units of the UNEP-GRID shapefile. In some cases, we changed the mapping unit of the UNEP-GRID shapefile back to the mapping unit of the original map. For example, polygons that were originally mapped as mapping unit 16b (Zanzibar-Inhambane forest patches), but had been assigned the mapping unit of "water" (most likely as a result from the blue colour of this mapping unit) were re-assigned as mapping unit 16b. Other changes were made for polygons 193, 215, 245, 258, 461 and 888.
- The colour scheme of the original vegetation map suggested that polygons 216 and 226 (occurring in Somalia) were absolute desert. We mapped these polygons as mapping unit 54b (Somalia-Masai semi-desert grassland and shrubland) instead since we restricted the mapping unit of absolute desert to the Sahara regional transition zone.
- We mapped Kakamega forest (polygon 460) as mapping unit 4b (transitional rain forest) rather than mapping unit 2 (drier types of Guineo-Congolian forest). We implemented this change because Kakamega forest was described as a transitional rain forest in the memoir (page 181; *i.e.* this forest contains several Afromontane species).
- Not all mapping units of the original map were mapped as polygons, as some were mapped as scattered symbols. We expanded the method of the UNEP-GRID shapefile of creating new polygons that roughly outlined sections of the map where larger concentrations of these symbols occurred. The UNEP-GRID shapefile had created these new polygons for mapping units 12 (mosaic of lowland rain forest, *Isobberlinia* woodland and secondary grassland) and 30 (Sudanian undifferentiated woodland with islands of *Isobberlinia*). We expanded this system to mapping units 13 (mosaic of lowland rain forest, secondary grassland and montane elements), 14 (mosaic of lowland rain forest, Zambezian dry evergreen forest and secondary grassland), 21b (mosaic of Zambezian dry evergreen forest and wetter miombo woodland) and 34 (transition from South African scrub woodland to Highveld grassland). We did not expand this system to mapping units 21a (mosaic of Zambezian dry evergreen forest and wetter miombo woodland) and 73 (oasis), but included these vegetation types as vegetation types with fragmented distribution within the other mapping units within which these mapping units were included.

The interactive physiognomic map (Africa\_physiognomic.kml) documents the major vegetation types and mosaics (as indicated in the legend of the original map; see above).

Instead of classifying mapping units 16b (Zanzibar-Inhambane forest patches), 19a (undifferentiated Afromontane vegetation) and 19b (undifferentiated Sahelomontane vegetation) as the major vegetation of forest transitions and mosaics (as in the original map), we classified these mapping units together with the major forest vegetation type.

## 5. Some limitations of the map

When using the tool, be aware of several of its limitations:

- Since the original map was prepared at a scale of 1 : 5,000,000, boundaries between mapping units may not be precisely represented when zooming in deeply into the interactive maps (moreover, not all vegetation types may have sharp boundaries but have transition zones such as ecotones or mosaics). If possible, verify that the natural vegetation of your area of interest corresponds to the description of vegetation of the mapping unit where your area is mapped - or whether the vegetation of your area of interest corresponds better to the vegetation of a nearby mapping unit.
- Most of the tree species that are listed are indigenous. This does not imply that we do not recommend planting of exotic tree species, but this simply was a result from having compiled lists of species assemblages from what were mainly descriptions of natural vegetation types (*i.e.* as available from White 1983). However, when you would decide to introduce exotic species, we strongly recommend that you adhere to biosafety guidelines - such as not to introduce species that could become invasive.
- When documenting species composition, we generally did not make a distinction between a general description of a vegetation type or a description of a vegetation type from a specific location (we thus assumed that species that occur locally are suitable throughout the mapped range of the vegetation type).
- Lists of "useful tree species" include tree and shrub species that are expected to be species that are useful for farming or pastoral communities. Although these species are known or expected to be good candidate species to be integrated in agroforestry systems, several species require shading (as provided by a closed canopy) for their regeneration.
- Uses of woody species are limited to those that were described in the references that we consulted.

## 6. The description of mapping units

We described each mapping unit in a separate htm file that is linked with the interactive vegetation map. Descriptions of vegetation type include:

- Name of the mapping unit
- Main vegetation type: name of the mapping unit in the legend
- Major vegetation type: physiognomic classification as indicated in the legend (see above)
- Phytochorion: phytochoristic classification (see above)
- Main subtypes: subtypes of the main vegetation type for which separate descriptions (and information on species composition) are provided in the memoir
- Main types: the identities of other mapping units in case that the focal mapping unit is a mosaic (for example, mapping unit 3 is a mosaic of mapping units 1a and 2a)
- Smaller areas of other mapping units: identities of vegetation types that are described for other mapping units, but that occur within the area mapped by the focal mapping unit. For example, smaller areas of Guineo-Congolian swamp forest (mapping unit 8) that occur within mapping unit 1a (wetter types of Guineo-Congolian rain forest).
- Other types not mapped separately: identities of vegetation types that are described separately in the memoir, but are not mapped separately. For example, Guineo-Congolian edaphic grassland within mapping unit 1a (wetter types of Guineo-Congolian rain forest).
- Species that were not included: information on species that were excluded from species composition tables (see below)
- Link to main composition tables: links to MS Excel tables with information on species composition (see below)
- Link to other composition tables: links to information of other mapping units mentioned in the description of the focal mapping unit (*e.g.*, smaller areas of other mapping units)

Page references in the description refer to the memoir that accompanies the Vegetation Map of Africa (White 1983).

## 7. Species composition tables in MS Excel

Information on species composition - including the suggestions for useful tree species that could be planted in the respective mapping units - are provided in species composition tables prepared in MS Excel. These species composition tables can also be opened with the OpenOffice Calc software (<http://www.openoffice.org>).

These tables provide the following types of information:

### Taxon

- The name of the plant species. The taxonomy of species was first checked via PROTA4U, an interactive web database on plants used by people in tropical Africa available from <http://www.prota4u.org/>. Species listed in the memoir and expected to be woody, but that were not listed in PROTA4U were checked for current taxonomic status via the *African Plant Database* available from <http://www.ville-ge.ch/musinfo/bd/cjb/africa/index.php?langue=en>.
- We listed most plants at the species level and did not differentiate between subspecies or varieties, whereas the memoir (White 1984) possibly made such differentiation
- Since the main objective of the species composition tables was to list woody species, we did not systematically check for current names of non-woody plants such as grasses, other herbs or mosses. Those species that we could identify as synonyms of species listed in PROTA4U were included in species composition tables, however.
- Groupings of species that were not included (such as grasses or mosses) were indicated in the main description of a mapping unit.

### Main vegetation type

- A YES/NO field that indicates whether the species occurs within the main vegetation type (YES) or not (NO). Note that the main vegetation type can consist of various subtypes.

### Hyperlinks

- PROTA: hyperlink to information on the species in the *Plant Resources for Tropical Africa* web database (<http://www.prota4u.org/>)
- AFD: hyperlink to information on the species in the Agroforestry database (<http://www.worldagroforestry.org/resources/databases/agroforestry>)
- TROPICOS: hyperlink to information on the species in the Tropicos database (<http://www.tropicos.org/>)

- PLANTLIST: hyperlink to information on the species in *The Plant List* (<http://www.theplantlist.org/>)
- APD: hyperlink to information on the species in the *African Plant Database* ([www.ville-ge.ch/musinfo/bd/cjb/africa](http://www.ville-ge.ch/musinfo/bd/cjb/africa))
- GBIF: hyperlink to information on the species in the Global Biodiversity Facility (<http://www.gbif.org/>)

We tried to utilize the current name of the respective databases. We checked for all species whether they occurred in the Tropicos database with the name matching tool of that database (<http://www.tropicos.org/NameMatching.aspx>).

### **Vegetation types**

- Here we cross-tabulated the plant species with the various vegetation types associated with a mapping unit. These associated vegetation types include the main vegetation type, possible vegetation subtypes and possible vegetation types that are not mapped separately.
- Note that we mainly focus on tree species (given that the name of the tool) and species that are listed in the *Plant Resources for Tropical Africa* web database.

### **PROTA star ratings**

**We highly appreciate the support of Gaby Schmelzer (PROTA) in compiling and sharing the star rating system.**

The star rating system of the PROTA4U interactive web database was developed to reflect the importance of a plant species in various categories (<http://www.prota4u.org/starratings.asp>).

Most of these categories are the following commodity groups: Cereals and pulses; Vegetables; Dye and tannins use; Ornamental use; Forage/feed use; Fruit use; Timber use; Carbohydrate/starch use; Auxiliary use; Fuel use; Medicinal use; Spices and condiment use; Essential oil and exudate use; Vegetable oil use; Stimulant use; and Fibre use.

The following rating applies within these commodity groups:

- 1 star: 1 paragraph on use and no information on properties
- 2 star: 2 paragraphs on use (or: 1 paragraph use + 1 paragraph relevant properties)
- 3 star: 3 paragraphs on use (or: 2 paragraphs use + 3 paragraphs relevant properties)
- 4 star: 4 paragraphs on use (or: 2–3 paragraphs use + 1 page relevant properties)
- 5 star: 1–2 pages on use (or: > 3–4 paragraphs use + 2 pages relevant properties)

Please consult the documentation of the star rating system (<http://www.prota4u.org/starratings.asp>) for information on the categories of: general

importance; geographic coverage Africa; geographic coverage worldwide; climate change; food security; and conservation status.

## Wood

- In first instance, information was compiled from the following five “useful tree species” manuals:
  - Bein E., Habte B., Jaber A., Birnie A. & Tengnas B. (1996). *Useful trees and shrubs in Eritrea. Identification, propagation and management for agricultural and pastoral communities*. Regional Soil Conservation Unit, Nairobi.
  - Bekele-Tesemma A. (2007). *Useful trees of Ethiopia: identification, propagation and management in 17 agroecological zones*. World Agroforestry Centre, Nairobi, Kenya.
  - Maundu P.M. & Tengnas T. (2005). *Useful trees and shrubs for Kenya*. World Agroforestry Centre.
  - Mbuya L., Msanga H., Ruffo C., Birnie A. & Tengnas B. (1994). *Useful trees and shrubs for Tanzania. Identification, propagation and management for agricultural and pastoral communities*. Regional Soil Conservation Unit, Nairobi.
  - Katende A., Birnie A. & Tengnas B. (1995). *Useful trees and shrubs for Uganda. Identification and management for agricultural and pastoral communities*. Regional Soil Conservation Unit, Nairobi.
- Where the five references agreed on the products or services provided by the species, we inserted a “x” in the table. Where the five references disagreed, we inserted a “p” (“**p**artial agreement”) in the table.
- For species that were not encountered in the references listed above, we compiled information from the following references (for most of these species, only one reference source was used):
  - Simute S.; Phiri C.L. & Tengnäs B. 1998. Agroforestry Extension Manual for Eastern Zambia. Nairobi, Kenya: Regional Land Management Unit (RELMA), Swedish International Development Cooperation Agency (Sida), 1998 (Regional Land Management Unit (RELMA) Technical Handbook Series; 17)
  - Nduwayezu J.B., Ruffo C.K., Minani V., Munyaneza E. & Nshutiyayesu S. 2009. Know Some Useful Trees and Shrubs for Agriculture and Pastoral Communities of Rwanda. Institute of Scientific and Technological Research (IRST), Butare, Rwanda
  - Fanshawe D.B. 1982. Useful trees of Zambia for the agriculturist. Ministry of Lands and Natural Resources, Republic of Zambia.
  - Agroforestree database (World Agroforestry Centre): Orwa C., Mutua A., Kindt R., Jamnadass R., Simons A. 2012. Agroforestree Database: a tree reference and selection guide. version 4.0  
<http://www.worldagroforestry.org/resources/databases/agroforestree>

- Arbonnier M. 2004. Trees, shrubs and lianas of West African dry zones. CIRAD, MNHN, Paris.

### **Human consumption**

- We used the same system as for information on wood (immediately above)

### **Animals**

- We used the same system as for information on wood (see above)

### **Environmental**

- We used the same system as for information on wood (see above)

### **Other uses**

- We used the same system as for information on wood (see above)

### **Information**

- Here we list the source of information on wood, human consumption, animals, environmental and other uses.
  - Zambia refers to the Simute et al. 1998 reference, not the Fanshawe 1982 reference (the latter reference is listed as “Fanshawe”)

Guidelines how these tables can be used are provided in an associated document ([Suggestions for selecting tree species.pdf](#)).

## 8. Acknowledgements

We are grateful to UNEP-GEF for having funded the Carbon Benefits Project where this species selection tool was developed. We are equally thankful to the Rockefeller Foundation for having funded the VECEA project that has contributed to the development of a database based on the Vegetation Map of Africa. The BMZ-funded ReACCT project funded field-testing of the VECEA map in the Morogoro region of Tanzania and thereby also contributed to the development of the *Useful tree species for Africa* website; we are also grateful for this support.

We highly appreciate the support of Gaby Schmelzer (PROTA) in compiling and sharing the star rating information.

We dedicate this new version of the *Useful Tree Species for Africa* to our former colleague Dennis Osino.



## 9. References

- Suggested citation: Kindt R., Orwa C., van Breugel P., Graudal L., Lillesø J.-P.B., Kehlenbeck K., Jamnadass R. and Neufeld H. 2012. Useful tree species for Africa: interactive vegetation maps and species composition tables based on the Vegetation Map of Africa. Version 1.1. World Agroforestry Centre, Nairobi.
- Original vegetation map: White F. 1983. *The vegetation of Africa*. UNESCO, Paris (shapefile accessed from <http://www.grid.unep.ch/data/index.php>)
- Google Earth software: <http://www.google.com/earth/download/ge/>
- Information on taxonomy of species:
  - Plant Resources of Tropical Africa (PROTA). <http://www.prota.org/>
  - Tropicos.org. Missouri Botanical Garden. Jul-Dec 2012. <http://www.tropicos.org>
  - The Plant List. Accessed 2012. Version 1. Published on the Internet; <http://www.theplantlist.org/>
  - African Plants Database (version 3.4.0). Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute, Pretoria, Retrieved Jul-Dec 2012, from <http://www.ville-ge.ch/musinfo/bd/cjb/africa/> >.
  - Global Biodiversity Information Facility: <http://data.gbif.org>
- Information on potential uses of tree species:
  - Agroforestree database (World Agroforestry Centre): Orwa C., Mutua A., Kindt R., Jamnadass R., Simons A. 2012. Agroforestree Database: a tree reference and selection guide. version 4.0 <http://www.worldagroforestry.org/resources/databases/agroforestree>
  - Arbonnier M. (2004). *Trees, shrubs and lianas of West African dry zones*. CIRAD, MNHN, Paris.
  - Bein E., Habte B., Jaber A., Birnie A. & Tengnas B. (1996). *Useful trees and shrubs in Eritrea. Identification, propagation and management for agricultural and pastoral communities*. Regional Soil Conservation Unit, Nairobi.
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- Maundu P.M. & Tengnas T. (2005). *Useful trees and shrubs for Kenya*. World Agroforestry Centre.
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